



ENGINE ICING CAPABILITY ENHANCEMENTS FOR PROPULSION SYSTEMS LABORATORY

The AC9C is holding their biannual committee meeting in Ottawa, Ontario on 18-20 October 2010. I have been asked to provide a short presentation of the status of the icing project upgrade to the PSL test facility. I will highlight the progress made during construction the past 6 months, our approach for checkout of the facility, and an overview of the system design and its capabilities. A copy of the presentation is attached.



Engine Icing Capability Enhancements For Propulsion Systems Laboratory

**John H. Glenn Research Center at
Lewis Field**

Project Update to the SAE AC9C Committee

October 19, 2010

Tom Griffin

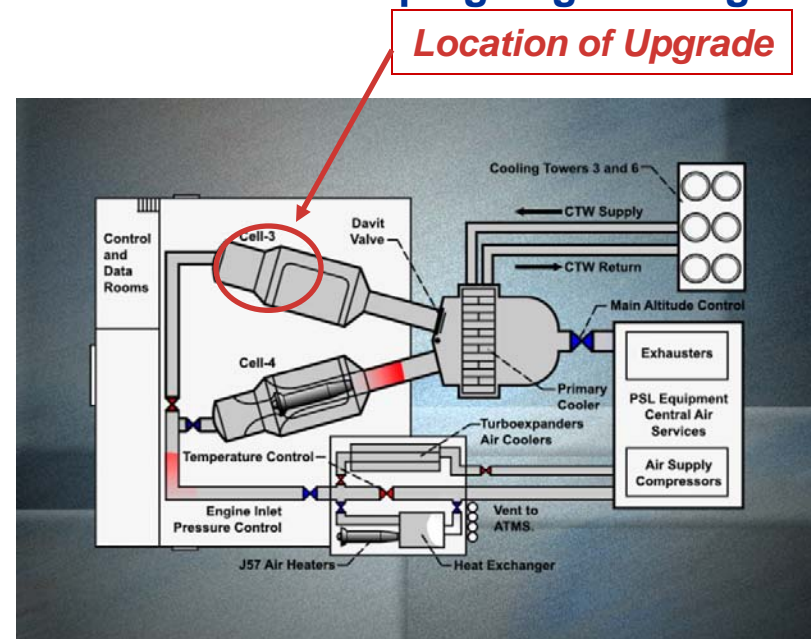
PSL Project Lead



PSL Icing

Goals and Future of Upgrade

- Enhance PSL to provide industry and government a facility that will address turbine engine core icing.
- Collaborate with industry/other government agencies to plan utilization of system.
- Build system that is versatile so it can be refined to meet developing engine icing requirements.



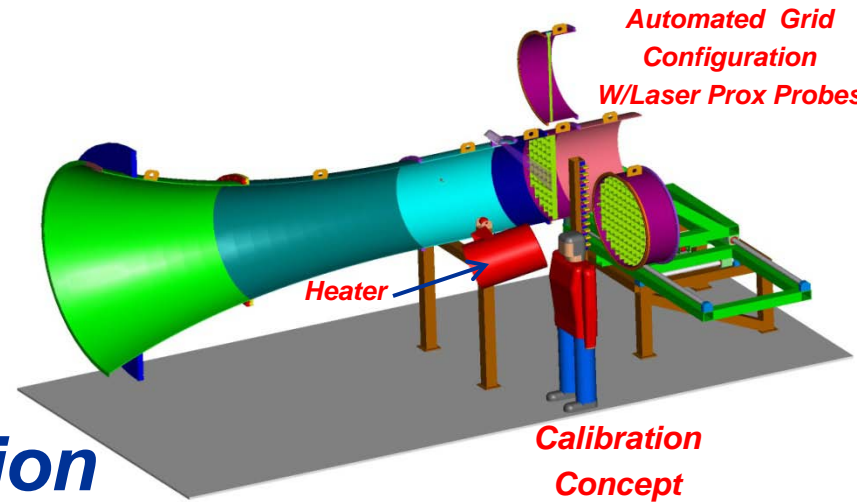
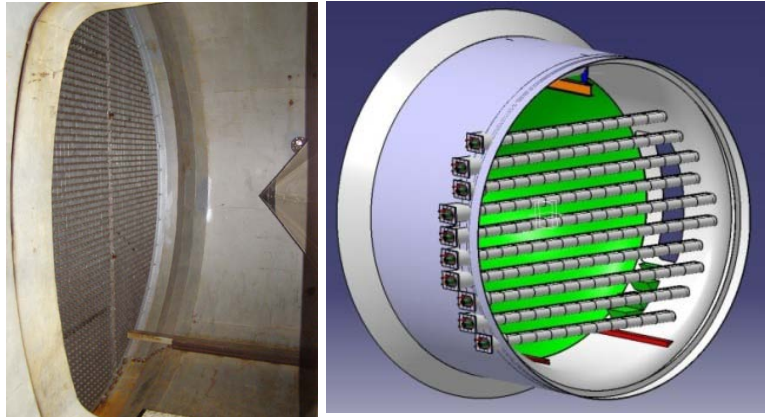


Facility Icing Upgrade Progress/Plan

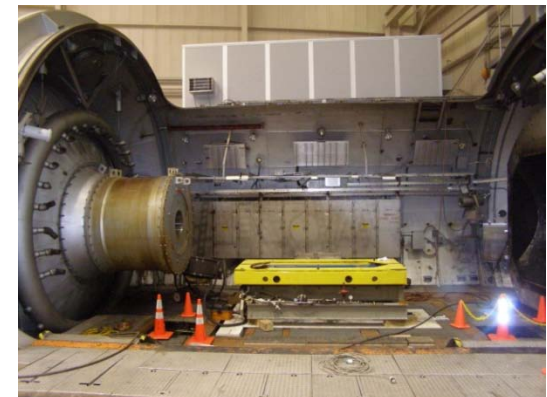
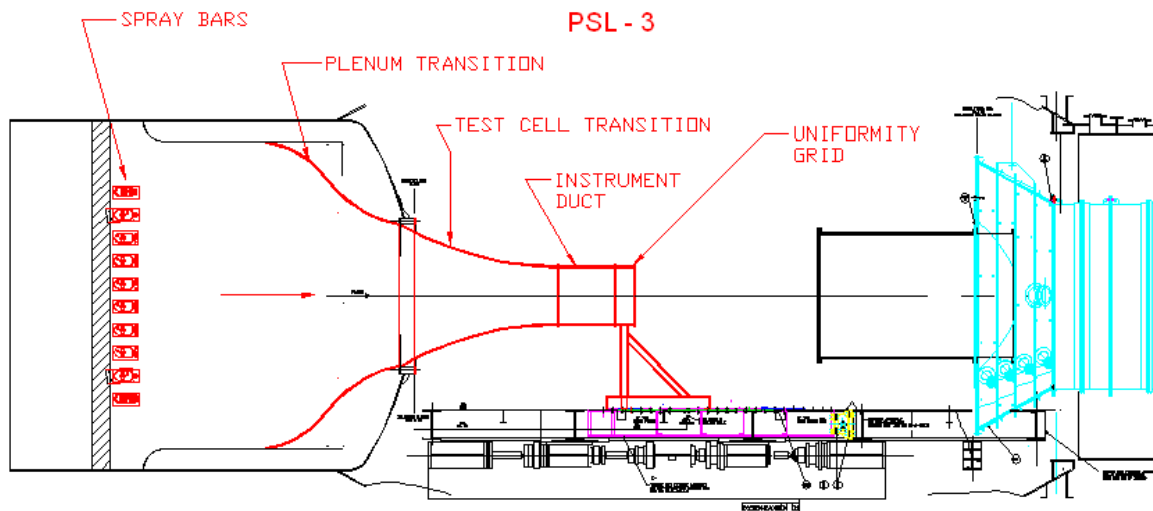
- Complete Icing System Installation in Summer 2011
 - Construction at 64% complete
 - Spray bar fabrication is proceeding
- Prepare for System Startup
 - Perform Technology Demonstration Tests in Cox Icing Tunnel
 - Develop hardware, instrumentation, controls, cameras, etc for tests
- Integrated Systems Test
 - System Checkouts
 - Full up Icing System Check
- Calibration Test
 - Verify Requirements are met
 - Document System Capabilities
- Validation Test
 - Seeking a cooperative test with engine manufacturer
 - Validate Against Existing Flight Data

PSL Icing System Description and Capabilities

Plenum

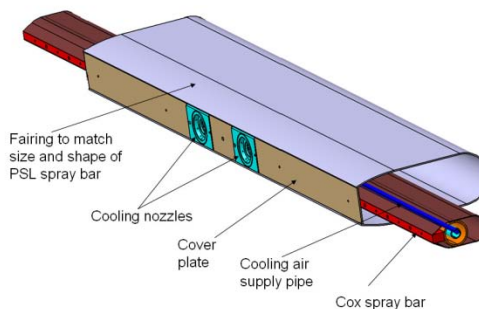
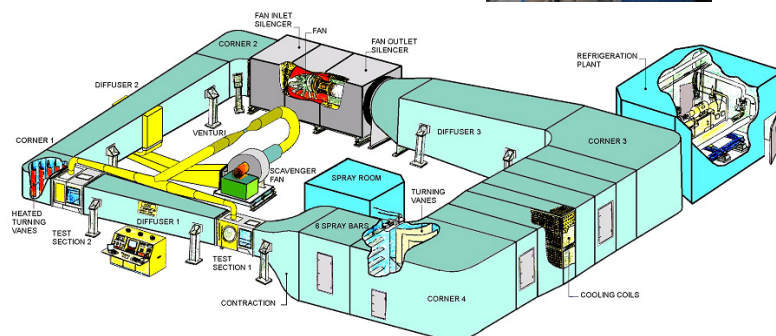
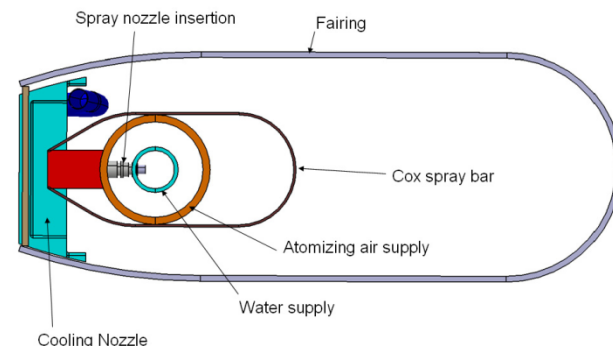
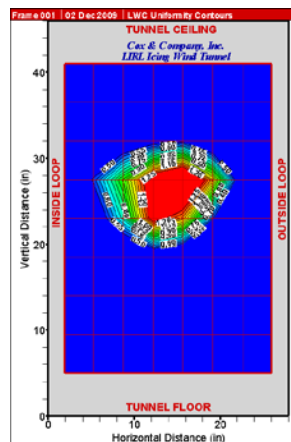


Icing Configuration



Technology Demonstration Tests Summary

- Proof of concept for generating ice particles
- Parametrics include Tunnel speed and temperature, Nozzle type, Cooling air pressure and temperature, Spray bar atomizing air and water pressures and temperatures
- Grid establishes cloud size, uniformity and center for instrument placement
- FSSP and OAP used to determine median volume droplet size (MVD) and distribution
- Multi-wire probe used to determine liquid and total water content (LWC, TWC) and freeze fraction

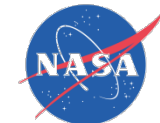




PSL Icing Capability to Meet Engine Core Icing Research Needs

Unique features PSL will provide:

- ✓ Altitude capability: (4000-40,000 ft.) No other existing engine facility can provide this capability.
- ✓ Ice Water Content: (0.5-9.0 g/m³) Very large range of water content is unique to HIWC icing. It is a key parameter to study the problem.
- ✓ Air Temperature: (15 to -60 deg F) Most existing and planned engine core icing test facilities are reliant upon cold weather for air supply temperature or have limited air temperature ranges. PSL provides a unique, wide range of temperatures.
- ✓ Full operating engine test capability will permit validation testing with a high confidence level.



Technical Requirements For PSL Icing

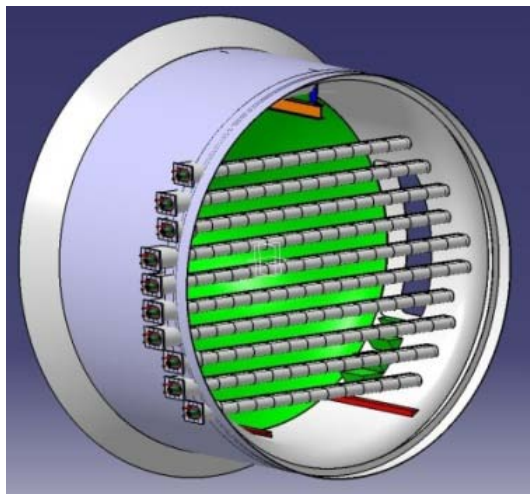
Specified Requirement		
Specification	Minimum	Maximum
Altitude (pressure)	4000 ft	40,000 ft
Inlet Total Temperature	-60°F	15°F
Mach Number	0.15	0.80
Air Flow Rate	10 lbm/sec	330 lbm/sec
IWC (icing water content)	0.5 g/m ³	9.0 g/m ³
MVD (mean volumetric diameter)	40μ	60μ
Run Time	Continuous up to 45 minutes	

- Requirements were created in conjunction with EHWG

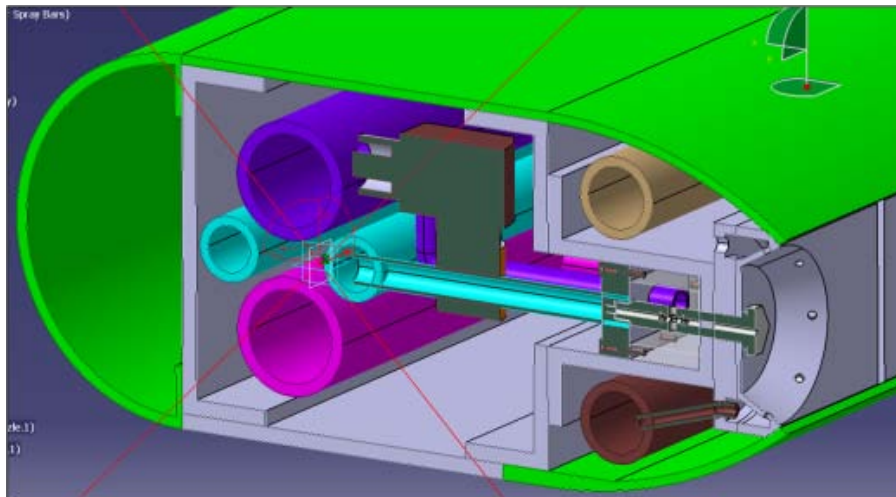
PSL Icing

System Description and Capabilities

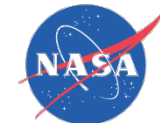
- **10 Spray Bars of 200+ Nozzles (2 types) mounted in PSL3 plenum that spray 35 F atomized water. Spray is cooled with -40 F air at nozzle exit to enhance freezing.**
- **System to be operated and controlled by the PSL Facility Control System from the Control Room**
- **System emphasizes versatility, flexibility and portability. Spray bars are removable**



PSL 3 Plenum Spray Bars



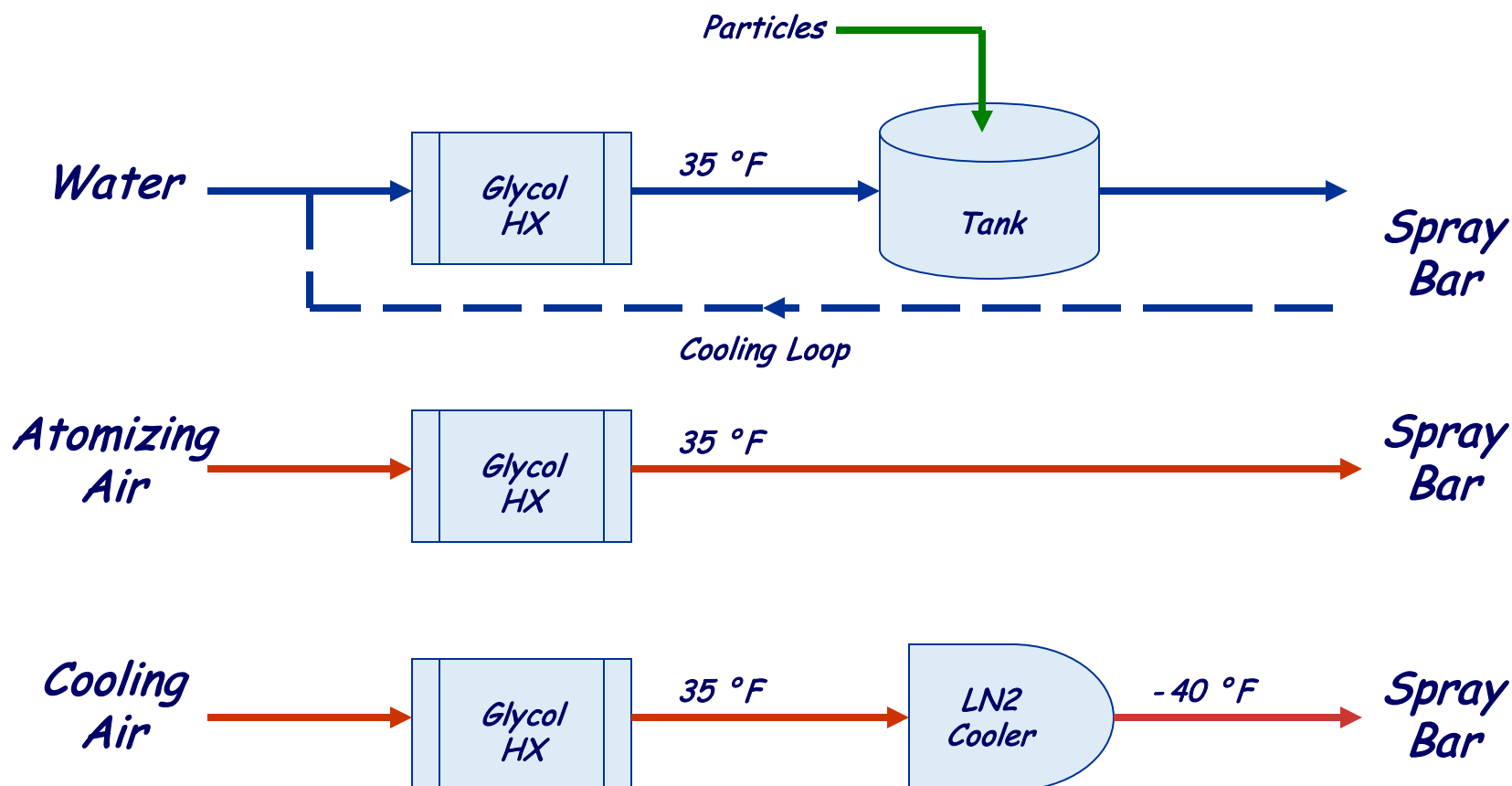
Spray Bar Detail



PSL Icing

System Description and Capabilities

Subsystems Design Summary



PSL Icing Progress

Water Tank



Air Dryer



Cooling/Atomizing Air HX



Glycol Chiller



Nitrogen Dewar



Glycol/Water HX



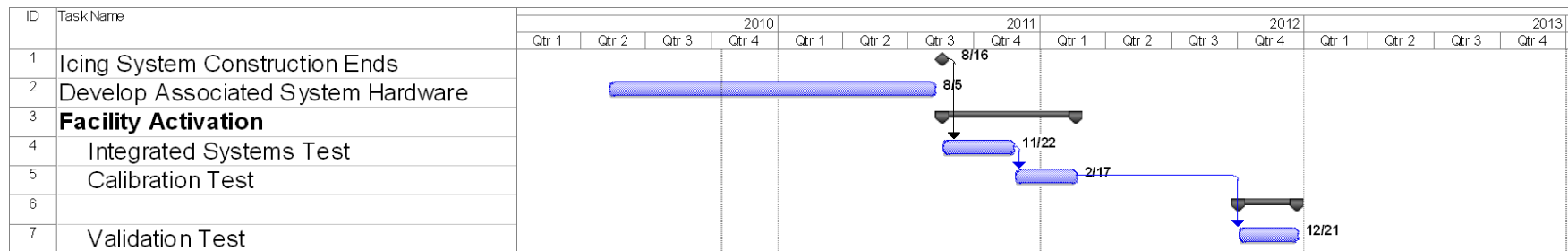
CONTROLS



Water Supply and Return Pipe
Atomizing and Cooling Air Supply



Facility Activation Schedule





Questions/Comments !